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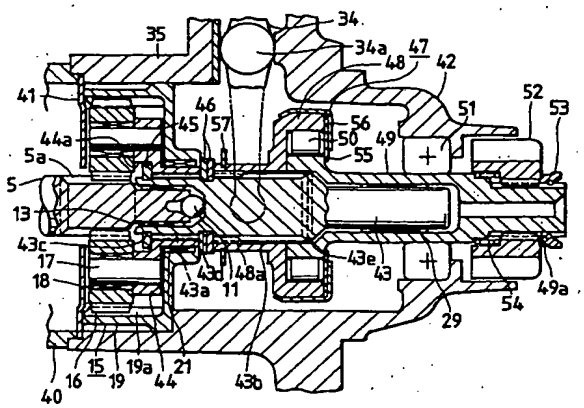
(54) Starter device.

(57) The invention relates to a starter device comprising: a planetary speed reduction gear (15) in which planet gears (16) revolve to reduce a rotation speed of the armature shaft (5) of an electric motor; a carrier (44) supporting the planet gears (16) and to which rotation of the armature shaft (5) is transmitted through the planetary speed reduction gear (15); an output shaft (43) in which the front portion is smaller in diameter than the rear portion, the output shaft (43) being engaged with the front end portion of the carrier (44) so that rotation is transmitted to the output shaft (43) through the carrier (44); a C-shaped snap ring (45) fitted in the output shaft (43) at the rear end to hold the rear end of the carrier (44); a E-shaped snap ring (46) fitted in the output shaft (43) ahead of the C-shaped snap ring (45) to hold the front end of the carrier (44); a clutch outer (48) which is coupled to the middle portion of the output shaft (43) through helical spline gears (48a) formed thereon so that rotation of the output shaft (43) is transmitted thereto; a clutch inner (49) in which the rear end portion thereof is coupled through a plurality of rollers (50) to the clutch outer (48), thus forming an over-running clutch (47) to transmit rotation in one direction; a bearing (51) fitted in a front bracket (42) of the electric motor to support the middle portion of the clutch inner (49); and a pinion (52) mounted on the front end portion of the clutch inner (49). The clutch inner (49) has a middle portion smaller in diameter, and a front end portion is smaller in diameter than the middle portion.

FIG. 1



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Background of the Invention

This invention relates to a starter device provided for an engine in which the rotation of the armature shaft of a DC motor is transmitted through a planetary speed reduction gear to the output shaft, and the rotation of the latter is transmitted to an over-running clutch to rotate a pinion thereby to start the engine.

Fig. 3 is a sectional side view showing essential components of a conventional starter device. In Fig. 3, reference numeral 1 designates a DC motor. An armature shaft 5 is extended from the armature 2 of the motor 1. A small gear, namely, a sun gear 5a is formed on the front end portion of the armature shaft 5. Further in Fig. 3, reference numeral 6 designates a yoke which has field magnets on its cylindrical inner wall. The yoke 6 is connected to a front bracket 8 and a rear bracket 9.

Reference numeral 10 designates an output shaft coupled through a steel ball 11 to the front end of the armature shaft 5 in such a manner that the former 10 is coaxial with the latter 5. The front end portion of the armature shaft 5 is engaged through a bearing 13 with a hole formed in the rear end face of the output shaft 10. Reference numeral 15 designates a planetary speed reduction gear designed as follows: Reference numeral 16 designates a plurality of planet gears engaged with the sun gear 5a which are supported through bearings 18 on support pins 17, respectively. The support pins 17 are fixedly embedded in a carrier 10a which is a flange formed on the output shaft 10 at the rear end. Reference numeral 19 designates an internal gear frame secured to the inner wall of the front bracket 8. The internal gear frame 19 has an internal gear 19a in its inner cylindrical wall, which is engaged with the planet gears 16 to turn the latter. The rear end portion of the output shaft 10 is supported through a bearing 21 on the inner cylindrical wall of the front end portion of the internal gear frame 19.

Further in Fig. 3, reference numeral 22 designates an over-running clutch mounted on the output shaft 10, which is a conventional one. The over-running clutch 22 is designed as follows: The over-running clutch 22 comprises a clutch outer 23 and a clutch inner 24. The clutch outer 23 has a helical spline gear 23a engaged with a helical spline gear 10b formed on the output shaft 10. The clutch inner 24 is adapted to transmit rotation through rollers 25 to the clutch outer 23 in one way. The clutch inner 24 is supported through a bearing 12 on the front bracket 8, and supports the front end portion of the output shaft 10 through a bearing 29. Further in Fig. 3, reference numeral 26 designates a pinion formed on the front end portion of the clutch inner 24, the pinion 26 being engaged with the ring gear of the engine as the over-running clutch moves forwardly; 27, an engaging ring which is mounted on the clutch outer 23 and secured with a snap ring; and 30, a stopper mounted on the output shaft 10, to regulate the forward position of the over-running clutch 22.

Further in Fig. 3, reference numeral 31 designates an electro-magnetic switch mounted on the front bracket 8. The electro-magnetic switch 31 has a movable iron core, namely, a plunger 32 with which a hook 33 is engaged in such a manner that the front end portion is protruded outside. The electro-magnetic switch 31 is provided with a shift lever 34. The upper end portion of the prongs of the shift lever are engaged with the hook 33, and the lower end portions with the engaging ring 27 in an axial direction. The shift lever 34 has a protruded portion 34a at the middle through which it is supported by the front bracket 8 in such a manner that the shift lever is swingable about it. A closing member 35 of rubber is fitted in a cut formed in the front bracket 8.

The operation of the conventional starter device thus constructed will be described. When the start switch of the engine installed, for instance, on a motor vehicle is turned on, the exciting coil (not shown) of the electro-magnetic switch 31 is energized, so that the plunger 32 is attracted inwardly; that is, it is moved backwardly to turn the shift lever 34 counterclockwise in Fig. 3 through the hook 33; that is, the over-running clutch 22 is moved forwardly. As a result, the pinion 26 is shifted into mesh with the ring gear of the engine. As the plunger 32 is moved backwardly as was described above, the movable contact is also moved backwardly into engagement of a pair of stationary contacts (not shown), thus completing the armature circuit of the DC motor 1. Hence, the armature 2 is rotated. The rotation of the armature 2 is transmitted through the planetary speed reduction gear 15 to the output shaft 10. The rotation of the output shaft 10 is transmitted through the over-running clutch 22 to the pinion 26, thereby to rotate the ring gear of the engine.

When the engine is started in this manner, it turns the pinion 26 in the same direction at high speed; however, the drive force is not applied to the side of the armature shaft 5 because the over-running clutch 22 is interposed therebetween.

As was described above, the pinion 26 is formed on the front end portion of the extension of the clutch inner 24. Therefore, when the specification of the pinion 26 is changed, it is necessary to change that of the over-running clutch. This is rather troublesome in production.

Furthermore, since the stopper 30 is provided inside the inner cylindrical wall of the pinion 26, the inside diameter of the latter 26 cannot be reduced,

and accordingly it is not permitted to reduce the number of teeth of the pinion 26. Moreover, the bearing 12 is mounted on the front end portion of the extension of the clutch inner 24, and therefore the outside diameter of the pinion 26 cannot be increased, and accordingly it is not permitted to increase the number of teeth of the pinion. Thus, in the conventional starter device, the pinion is greatly limited in the degree of freedom in designing it.

Furthermore, the outside diameter of the extension of the clutch inner 24 must be equal to or larger than the outside diameter of the pinion 26. This may result in an increase in weight of the clutch inner, adversely affecting the meshing of the pinion with the ring gear of the engine.

Summary of the Invention

Accordingly, an object of this invention is to eliminate the above-described difficulties accompanying a conventional starter device. More specifically, an object of the invention is to provide a start device in which the limitation on the change in the number of teeth of the pinion is eased to make it unnecessary to change the over-running clutch, and in which the clutch inner is reduced in weight, thus allowing the pinion to smoothly mesh with the ring gear.

In a starter device according to this invention, the front half of the output shaft is smaller in diameter than the rear half, the carrier supporting the planet gears through support pins is mounted on the rear end portion of the output shaft, and circumferentially engaging means is employed to transmit the rotation. A first snap ring is fitted in the output shaft at the end, to hold the rear end of the carrier. The clutch outer of the over-running clutch is mounted on the front portion of the rear half of the output shaft in such a manner that the former is coupled to the latter through spline gears formed thereon. A second snap ring is fitted in the output shaft between the front end of the carrier and the rear end of the clutch outer. The middle portion of the clutch inner, which is made smaller in diameter than the rear end portion, is supported through a bearing on the front bracket, and supports the output shaft through a bearing. And the front end portion of the clutch inner, which is made smaller in diameter than the middle portion, supports the pinion through spline gears formed thereon.

In the starter device of the invention, the front half of the output shaft, the middle portion of the clutch inner put on the front half of the output shaft through the bearing is smaller in diameter, and the front end portion of the clutch inner is smaller in diameter than the middle portion, and is engaged with the pinion through the spline gears formed thereon. Owing to this construction, the weight of the clutch inner is reduced, and it can be achieved with ease to change the number of teeth of the pinion. The clutch outer is mounted on the rear half of the output shaft from behind in such a manner that the former is engaged with the latter through helical spline gears formed thereon. Thereafter, the carrier is mounted on the rear end portion of the output shaft, and is then moved towards the clutch outer to expose the rear end portion of the output shaft. Under this condition, the first snap ring is fitted in the output shaft. Then, the carrier is moved backwardly to cause the first snap ring to hold the bottom of a circular recess formed in the carried. A second snap ring is fitted in the output shaft between the front end of the carrier and the rear end of the clutch outer, to hold the rear end of the carrier, thereby to secure the carrier to the output shaft in a direction of axis.

Brief Description of the Drawings

Fig. 1 is a longitudinal sectional view showing essential components of one example of a starter device according to this invention.

Fig. 2 shows a procedure of mounting a carrier and a clutch outer on an output shaft. More specifically, the part (A) of Fig. 2 is a sectional view showing the clutch outer and the carrier mounted on the output shaft with a first snap ring fitted in the latter, and the part (B) of Fig. 2 is a sectional view showing a second snap ring fitted in the output shaft with the carrier moved backwardly to be set in place.

Fig. 3 is a sectional side view showing essential components of a conventional starter device.

Embodiment(s) of the Invention

Fig. 1 shows one example of a starter device according to this invention. In Fig. 1, reference numerals or characters 5, 5a, 11, 13, 15 through 19, 19a, 21, 29, 34, 34a and 35 designate the same components as those in Fig. 3, and a DC motor 1 (not shown) and an electro-magnetic switch 31 (not shown) are also the same as those in Fig. 3. Further in Fig. 1, reference numeral 41 designates an end plate mounted on the yoke 40 of the DC motor; 41, a front bracket coupled to the yoke 40; and 43, an output shaft which supports the front end portion of the armature shaft 5 with a bearing 13. The output shaft 43 is coupled to the armature shaft 5 through the steel ball 11 in such a manner that the former 43 is coaxial with the latter 5. A spline gear 43a is formed on the rear end portion of the output shaft 43. In addition, a helical spline gear 43b is formed on the rear end portion of the output shaft 43 between the spline gear 43a and the middle thereof. A stopper 43e is mounted on

the rear end portion of the output shaft 43 so as to abut against a helical spline gear formed on the clutch outer. The front half of the output shaft is smaller in diameter than the rear half. Further in Fig. 1, reference numeral 44 designates a carrier comprising a flange, and support pins 17 embedded in it. The carrier 44 is engaged with the output shaft 43 at the rear end, in such a manner that it is coupled to the spline gear 43a. The carrier 44 is held on the output shaft 43 as follows: A first snap ring (such as a C-shaped snap ring) 45 mounted on the output shaft 43 at the rear end holds the rear end of the carrier 44, and a second snap ring (such as an E-shaped snap ring) 46 mounted on the output shaft 43 holds the front end of the carrier 44.

Further in Fig. 1, reference numeral 47 designates an over-running clutch mounted on the output shaft 43 in such a manner that it is movable along the latter 43. The over-running clutch 47 is designed as follows: That is, the over-running clutch 47 comprises: a clutch outer 48 with a helical spline gear 48a which is engaged with the helical spline gear 43b of the output shaft for transmission of rotation; and a clutch inner 49 for transmitting rotation through rollers 50 to the clutch outer 48 in one direction. The clutch inner 49 has a middle portion smaller in diameter at which it is supported through a bearing 51 on the front bracket 42 and supports the front end portion of the output shaft 43 through a bearing 29. The front end portion of the clutch inner 49 is smaller in outside diameter than the middle portion, and has a spline gear 49a on it. An engaging ring 57 is fixedly mounted on the clutch outer 48, in such a manner that it is engaged with the end portion of the shift lever 34.

Further in Fig. 1, reference numeral 52 designates a pinion which is put on the front end portion of the clutch inner 49 in such a manner that it is spline-connected to the latter. A stopper 53 is provided to hold the pinion 52 at the front end, and the pinion 52 is urged forwardly by a compression spring 54. The carrier 44 and the clutch outer 48 are coupled to the output shaft 43 as shown in Fig. 1. First, as shown in the part (A) of Fig. 2, the clutch outer 48 is fitted on the middle portion of the output shaft 43 from behind until the helical spline gear 48a is engaged with the helical spline gear 43a. Next, the carrier 44 is mounted on the rear end portion of the output shaft 43 from behind in such a manner that the former is spline-connected to the latter and abuts against the front end (sic) of the clutch outer 48. Under this condition, a first annular groove 43c (sic) provided for the snap ring to hold the front end of the output shaft is exposed. The first snap ring 45 is fitted in the groove. As shown in the part (b) of Fig. 2, the carrier 44 is moved backwardly until the bottom of a circular recess 44a formed therein abuts against the first snap ring 45. Under this condition, the inner cylindrical wall of the circular recess 44a covers the snap ring 45, thus preventing the radial movement of the snap ring. The output shaft 43 has a second annular groove formed for the second snap ring 46. The second snap ring 46 is fitted in the second annular groove 43d exposed, to hold the carrier 44 at the front end and to regulate the backward position of the clutch outer 48.

As shown in Fig. 1, the clutch inner 49 is put on the front half of the output shaft 43 from ahead in such a manner that it is mounted through the bearing 29 on the output shaft 43. A plurality of rollers 50 are interposed between the clutch outer 48 and the clutch inner 49, and compression springs (not shown) are set to push the rollers circumferentially. Under this condition, the clutch outer and the clutch inner are coupled to each other through an end plate 55 with a cap 56.

When, in the starter device thus constructed, the shift lever 34 is turned (counterclockwise in Fig. 1) by the electro-magnetic switch, the over-running clutch is moved forwardly to engage the pinion 52 with the ring gear of the engine. In succession to this, the DC motor is started, to rotate the armature shaft 5. The rotation of the armature shaft 5 is transmitted through the planetary speed reduction gear 15 and through the carrier 44 to the output shaft 43. The rotation of the output shaft 43 is transmitted through the over-running clutch 47 to the pinion 52 to rotate the ring gear of the engine; i.e., to rotate the engine.

The pinion 52 is mounted on the front end portion small in diameter of the clutch inner 49, with the stopper 53 set outside. Therefore, the inside diameter of the pinion 52 can be reduced, and the outside diameter can be set to a desired value. That is, in the starter device of the invention, the designing of the pinion is higher in the degree of freedom, and it is unnecessary to change the specification of the over-running clutch 47 when that of the pinion is changed.

As was described above, in the starter device of the invention, the rotation reduced in speed by the revolution of the planet gears is transmitted to the carrier, and then to the output shaft coupled to the front end portion of the carrier, and the over-running clutch is mounted on the output shaft so that the rotation of the output shaft is transmitted through the over-running clutch to the pinion. In this connection, the clutch inner of the over-running clutch is so designed that its middle portion is reduced in diameter, and the front end portion is made smaller than the middle portion to support the pinion. Hence, in increasing or decreasing the number of teeth of the pinion, the degree of free-

dom is increased as much. Accordingly, in the starter device of the invention unlike the conventional one, it is unnecessary to change the specification of the over-running clutch when that of the pinion is changed. In addition, the above-described construction contributes to reduction of the weight of the clutch inner, thus allowing the pinion to smoothly mesh with the ring gear of the engine.

While the the present invention has been described in relation to the preferred embodiments, and modifications thereof, the scope of the present invention is not confined to these embodiments and modifications, but may be modified or practiced in various ways without departing from the spirit or essential character of the invention as recited in the appended

Reference signs in the claims are intended for better understanding and shall not limit the scope.

Claims

1. A starter device comprising:
   an planetary speed reduction gear (15) in which planet gears (16) revolve to reduce a speed of rotation of the armature shaft (5) of an electric motor (1);
   a carrier (44) supporting said planet gears, to which rotation of said armature shaft is transmitted through said planetary speed reduction gear (15);
   an output shaft (43) in which the front portion is smaller in diameter than the rear portion, said rear portion of said output shaft (43) being engaged with said carrier (44), so that rotation is transmitted to said output shaft (43) through said carrier (44);
   a first snap ring (45) fitted in the output shaft (43) at the rear end, to hold the rear end of said carrier (44);
   a second snap ring (46) fitted in the output shaft (43) ahead of said first snap ring (45), to hold the front end of said carrier (44);
   a clutch outer (48) which is coupled to the middle portion of said output shaft (43) through helical spline gears (48a) formed thereon so that rotation of said output shaft (43) is transmitted thereto;
   a clutch inner (49) in which the rear end portion thereof is coupled through a plurality of rollers (50) to said clutch outer (48), thus forming an over-running clutch (47) to transmit rotation in one direction,
   said clutch inner (49) having a middle portion smaller in diameter, and a front end portion smaller in diameter than said middle portion;
   a bearing (51) fitted in the front bracket (42) of said electric motor (1), supporting said middle portion of said clutch inner (49); and
   a pinion (52) mounted on said front end portion of said clutch inner (49).

2. A starter device according to claim 1, further comprising:
   a stopper (53) provided to hold said pinion (52) at the front end; and
   a spring (54) by which said pinion (52) is urged forwardly.

3. A starter device according to claim 1, wherein said first snap ring is a C-shaped snap ring (45).

4. A starter device according to claim 1, wherein said second snap ring is a E-shaped snap ring (46).

FIG. 1

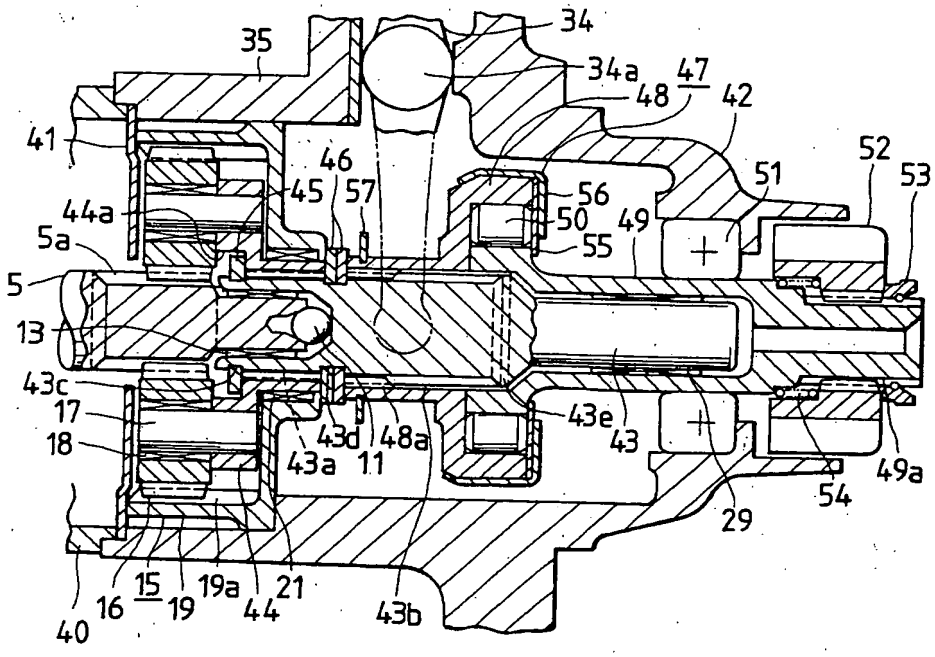


FIG. 2(A)

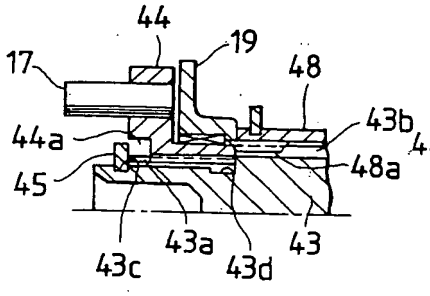


FIG. 2(B)

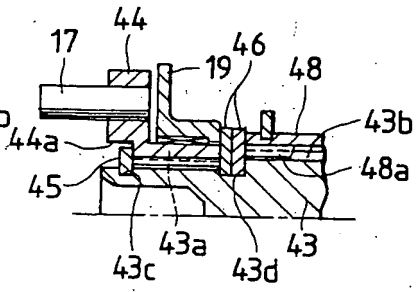
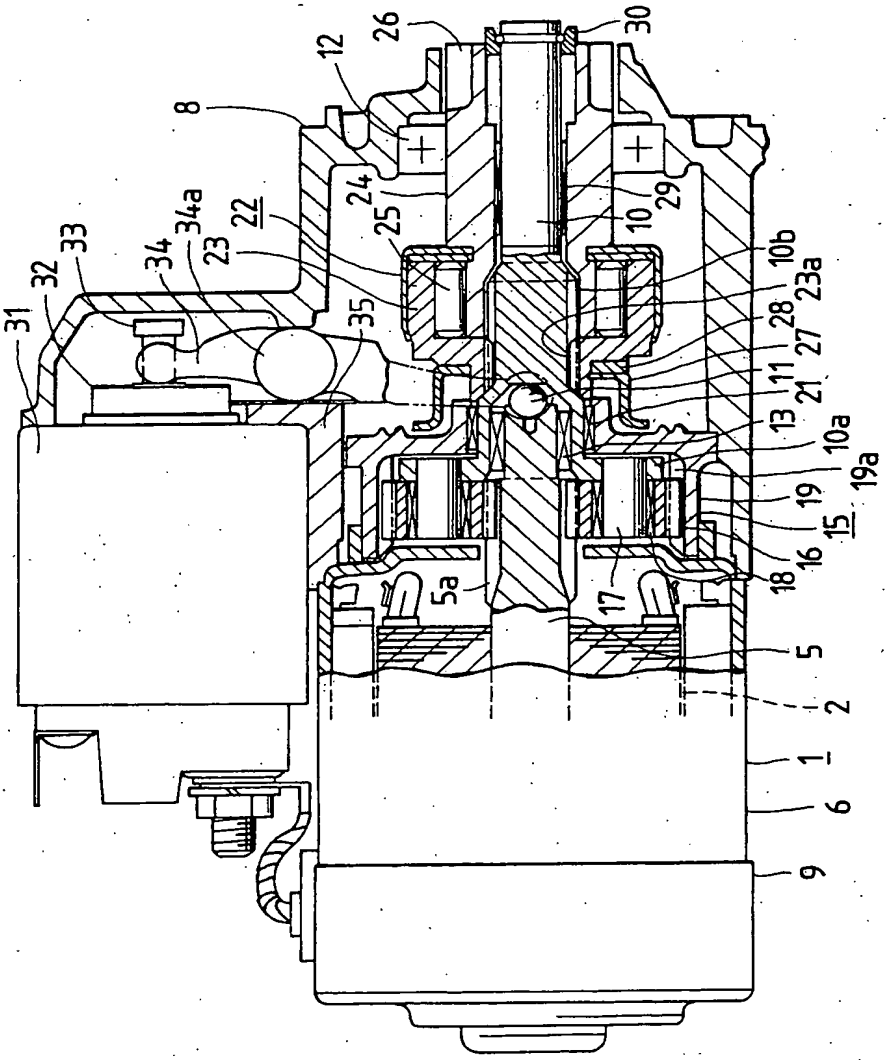


FIG. 3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EUROPEAN SEARCH REPORT

Application Number

EP 92 10 2307

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-4 818 889 (KINOSHITA) * column 2, line 59 - line 66; figure 1 *	1	F02N15/06 F02N15/04
A	---	2	
Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 277 (M-519)(2333) 19 September 1986 & JP-A-61 098 962 (HITACHI LTD) 17 May 1986 * abstract *	1	

			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F02N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 MAY 1992	BIJN E.A.

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